# USE OF THE "TANK RESISTANCE COEFICIENT" TO EVALUATE MODIFICATIONS OF WATER INLET DEVICES IN ROTATING FLOW TANKS

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## Introduction

The Tank Resistance Coefficient (*Ct*) was defined by Oca and Masaló (2007) to evaluate circular tanks and rectangular tanks with rotating flow cells. This coefficient is also very useful in order to adjust water velocity inlet to a desired mean water velocity inside the tank to maintain the optimal conditions for fish growth and welfare.

In a rotating flow tank, the impulse force from the inlet pipes to the rotating cells $F_i$ will be:

$$F_i = \rho Q (V_2 - V_1) \tag{1}$$

*where ρ is the density of water, Q the injected water flow rate and $V_1$ and $V_2$ the mean circulating velocity in the tank and the jet velocity from the inlet.*

The impulse force $F_i$ applied to the fluid in the tank that is moving at a velocity $V_1$, provides a power input $P_i$:

$$P_i = F_i V_1 = \rho Q (V_2 - V_1) V_1 \tag{2}$$

In a turbulent regime, the total resistive force to water circulation in the tank $F_t$ can be calculated as:

$$F_t = Ct\ A\ \rho \frac{V_1^2}{2} \tag{3}$$

*where Ct is the Tank Resistance Coefficient of the tank and A the wet area.*

And the power consumption ($P_t$) due to the resistive force ($F_t$) is:

$$P_t = F_t V_1 = Ct\ A \rho \frac{V_1^3}{2} \tag{4}$$

Assuming steady-state conditions, $P_i$ is equal to $P_t$. Under such conditions, the following expression gives the experimental determination of the resistance coefficient for a specific tank:

$$Ct = \frac{2Q(V_2 - V_1)}{A V_1^2} \tag{5}$$

When *Ct* is experimentally determined by a specific tank, it will be easy to predict the mean circulating velocity, from the water inlet flow rate and velocity. Taking:

$$V_1 = \sqrt{\frac{2Q(V_2 - V_1)}{A\, Ct}} \tag{6}$$

*Ct* will be also useful to evaluate the resistance of water circulation for different tank geometries and inlet and outlet placements.

The aim of this work is to evaluate the differences in *Ct* produced in identical tanks with rotating flow cells when water entries are doubled. Lower values of *Ct* will show a lower influence of resistive forces and will increase $V_1$ values for identical $Q$ and $V_2$ values.

## Materials and methods

Experiments were carried out using a circular tank 49cm diameter, and a rectangular tank 200cm long and 35cm wide, with 6 and 4 rotating flow cells (Figure 1) with length/width ratios 0.95 and 1.43 respectively (Oca and Masaló, 2007). Water depth was always around 6cm. Oblique Baffles where used in the midpoint of two opposite water inlets to improve water circulation.

Two types of water inlet were tested: one consisting of a single water jet entry (simple) for each rotating cell with the water jet 3cm depth, and another one, consisting of double water jet entry with jets placed 2 and 4cm depth. Drains were located in the bottom centre of each rotating cell area (Figure 1).

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Particle Tracking Velocimetry (PTV) was used to obtain velocity fields and average velocity in a horizontal plane at the midpoint of the water depth (Oca et al, 2004).

Results and Discussion

In experiments with double water inlets, a lower Tank Resistance Coefficient (*Ct*) was obtained for each configuration. It means that double water inlets will produce higher mean velocities than single water inlets.

The Tank Resistance Coefficient (*Ct*) showed to be a useful tool to evaluate the influence of different inlet devices in water circulating velocities for rotating flow tanks.

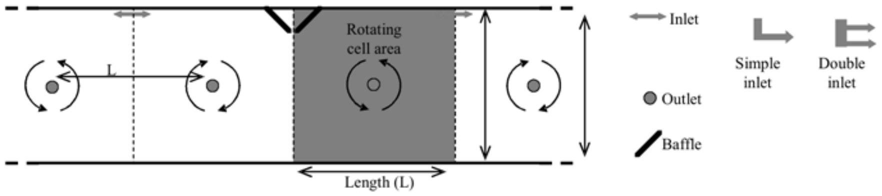


**Figure 1:** Rectangular tank showing inlet and outlet placements, and rotating cell areas.

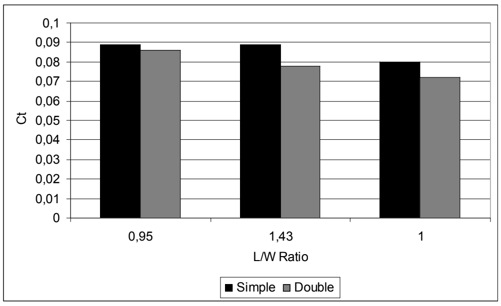


**Figure 2:** Resistance Coefficient (Ct) for each tank configuration.